Diphtheria on Skid Road, Seattle, Wash., 1972–75

THE TERM "SKID ROAD" originated in Seattle and describes the place where logs were skidded downhill to the water's edge. It is now frequently used to describe that central, decaying area of many large cities where most destitute male alcoholics live. It contains the missions, taverns, transient hotels, and low-cost housing units that provide food and shelter for the alcoholics.

From July 1972 to December 1975, Seattle's Skid Road (estimated population 5,000) was the focus of a persistent epidemic of skin diphtheria. The initial phase of the outbreak was characterized by a series of patients with nasopharyngeal diphtheria that could not be clearly linked. Three deaths occurred during the first 4 months, and there was concern regarding the possibility of a large-scale outbreak involving other areas of the community. A more intensive medical surveillance was necessary to define the extent of the threat before a control program could be properly developed.

Historical Background

Records available since 1883 show a variable yearly incidence of diphtheria, mainly among children, that did not significantly decline until the mid–1920s. More than 10,000 persons suffered from diphtheria during 1883–1957. The overall case fatality rate was 10 percent.

During World War II a definite trend began toward infection in adults. Adults accounted for 8 of 11 deaths during 1943. To our knowledge, diphtheria was not reported to be a local problem again until the early 1960s (*1*). At that time, wound infections among prisoners in the city jail were found to contain a mixed bacterial flora which occasionally included toxigenic *Corynebacterium diphtheriae*. Between 1967 and July 1972 only 1 isolation of toxigenic *C. diphtheriae* was found among 374 cutaneous cultures examined. Before the summer of 1972 there was no indication of an unrecognized problem with either nasopharyngeal or skin diphtheria in Seattle or King County. Only sporadic cases involving residents of Skid Road or low-cost housing projects had been recorded since 1957 and between 1962 and 1965, before discontinuation of the service, the health department had processed and screened for diphtheria and had not found a single isolate.

Method

Diagnostic criteria. The criteria used to define cases and carriers were as follows:

Case—A patient with respiratory tract symptoms whose nose or throat culture yields *C. diphtheriae,* regardless of biotype or toxigenicity, or a patient with a subacute or chronically infected skin lesion that yields *C. diphtheriae,* regardless of biotype or toxigenicity.

Carrier—An asymptomatic patient whose nose or throat culture yields *C. diphtheriae,* regardless of biotype or toxigenicity.

Recidivist—A patient who has been infected with diphtheria, treated, determined to be culture negative, and who subsequently returns with infection

at least 10 days after treatment. The subsequent site of infection may be the same or different.

Patient screening procedure. Nose cultures were obtained by use of a calcium alginate swab that reaches deep into both posterior nares. A Loeffler's slant was then streaked, and the swab was left on the surface of the medium.

Throat cultures were obtained by use of a cotton-tipped applicator that was streaked on a Loeffler's medium slant. Tonsillar fossae, posterior pharynx, and retro-uvular areas were sampled. If the patient was symptomatic, a direct smear slide was prepared before streaking the Loeffler's medium.

Wound cultures were obtained by first cleansing the area of infection with sterile normal saline and removing crusted material. A cotton-tipped applicator was then firmly applied to the bottom of the wound and streaked on the Loeffler's medium. If multiple skin lesions were present, a maximum of three were sampled.

Laboratory procedure. Loeffler slants, upon arrival in the laboratory, were incubated at 35°C after removal of swabs. Each swab was then used to streak Tellurite and blood agar plates that were incubated at 35°C. All cultures were examined for colony growth in 24 and 48 hours. Growth noted on any culture was smeared on slides for morphologic examination of organisms. If characteristic organisms of *C. diphtheriae* were found, typical colonies were subcultured on Tellurite medium for future typing and toxigenicity tests. The isolates were frozen at −70°C in 50 percent tryptocase broth and horse serum. Initially, all positive cultures were double checked in the special pathogens laboratory of the Center for Disease Control in Atlanta for toxigenicity and biotyping. Because of excellent correlations obtained, this double checking was later discontinued. During 1975 the Elek plate method was used for toxigenicity tests (*2*). This method has markedly shortened the time required for definitive diagnosis.

Readings on direct smears from patients with respiratory symptoms were interpreted by our most experienced microbiologist only. Such readings were extremely helpful in presumptive diagnosis—often necessary in implementing effective quarantine.

Results

Demography of the high-risk area. Figure 1 shows the census tracts of downtown Seattle where most diagnosed diphtheria cases and carriers reside. Tract 92, the original Skid Road, and waterfront portions of tracts 81 and 82 are presently defined as Skid Road. The 1970 census lists the residential population of the Skid Road area as nearly 5,000. Included are 61 children under age 15 and 1,500 adults over age 70. More than 80 percent are men with a mean age of 55. Approximately 70 percent are white, 11 percent Native American, 8 percent black, and the

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remainder Spanish- or Oriental-speaking peoples. There is a high degree of mobility among younger males, especially during the summer months. An estimated 40 percent of the residential population are heavy alcohol users.

Seattle's major business, financial, medical, and government facilities are in the downtown tracts. The daytime work force numbers about 92,000 persons who live in various areas of the city and county.

Morbidity and mortality. During the 42-month period included in this report, 334 (60 percent) of the diphtheria cases and carriers originated within the presently defined Skid Road.

Table 1 depicts the predominant demographic characteristics associated with all cases and carriers.

Figure 1. Skid Road and contiguous area census tracts, Seattle, Wash., 1970

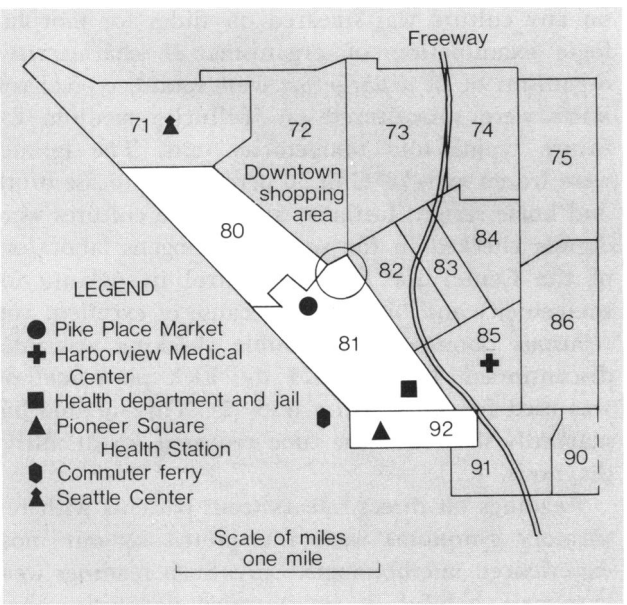
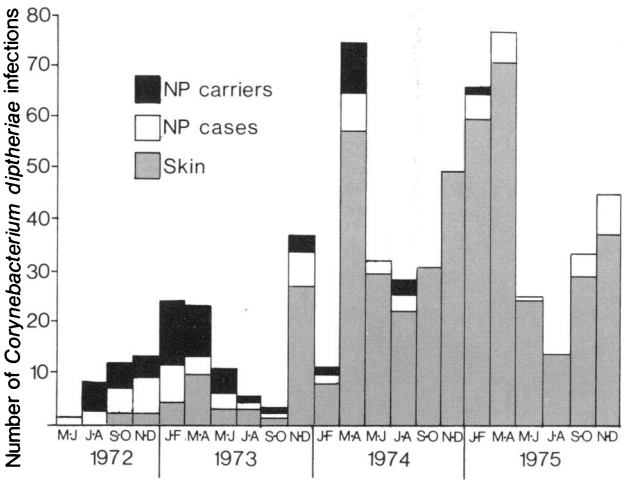


Table 1. Predominant demographic characteristics of persons infected with *C. diphtheriae,* Seattle, Wash., July 1, 1972–Dec. 31, 1975

Characteristic	*Total infected*	*Percent infected*	*Skin cases*	*Percent infected*
Total	558	100	414	100
Adult	522	93	411	99
Heavy drinker	392	75	390	95
Skid Road dweller	313	56	280	67
Male	473	84	370	90
American Indian	217	39	188	45

Figure 2. Diphtheria incidence, by 2-month intervals, Seattle-King County, May 1972–December 1975



Only nine persons in the daytime work force developed diphtheria infections or became carriers. Rates of infection among children and the aged were low.

Nasopharyngeal diphtheria or post-diphtheritic complications have caused death in three white men, all 48 years old or older. Skin diphtheria has caused 1 death and 17 eye infections. The eye infections caused total vision loss in one person and partial vision loss in two others. One person required enucleation surgery.

Progression of the epidemic, by type of infection, is shown by 2-month intervals in figure 2. The outbreak was regarded initially as nasopharyngeal disease and caused three of the four deaths during the first 3 months. A notable shift toward skin cases was evident by October 1973.

Thirty-six persons under the age of 20 were found to harbor *C. diphtheriae;* 19 were classified as carriers, and the remaining 17 were only mildly ill. Three of these 17 persons had skin diphtheria. Although students and teachers of nine schools had been exposed to persons with diagnosed cases and carriers, only one teacher and one pupil became secondarily infected.

Table 2 shows the geographic distribution of infected persons and carriers by ethnic groups and average annual attack rates for each group. Table 3 shows age and sex distribution of infected persons and carriers by type of infection.

Although first noted in 1972, recidivism did not become significant until 1974. At the time of this study, 66 persons had 110 episodes of reinfections

Table 2. Average annual diphtheria attack rates, based on first episode of infection only, by area, type of infection, and race, Seattle, Wash., July 1, 1972–Dec. 31, 1975

Area and race	Number of infections and annual rate per 10,000					
	Nasopharynx		Skin with or without nasopharynx		Carriers	
	Number	Rate	Number	Rate	Number	Rate
Skid Road census tracts:						
White	17	14	140	111	9	7
Indian	14	209	125	1,870	10	150
Black	0	0	6	36	1	6
Spanish	2	95	8	381	0	0
Other [1]	0	0	1	6	1	6
Total	33	20	280	167	21	13
Census tracts adjacent to Skid Road:						
White	8	1	42	4	7	1
Indian	8	39	39	190	4	20
Black	1	1	3	3	0	0
Spanish	1	4	3	11	1	4
Other [1]	0	0	0	0	0	0
Total	18	1.5	87	7	12	1
Remaining census tracts in Seattle and King County:						
White	14	0.04	21	0.06	9	0.03
Indian	7	3	24	10.4	16	6.9
Black	2	0.2	0	0	7	0.5
Spanish	3	0.4	2	0.3	0	0
Other [1]	0	0	0	0	2	0.2
Total	26	0.07	47	0.12	34	0.09

[1] Includes mostly Asians of Chinese, Filipino, Japanese, and Korean origins.

Table 3. Diphtheria by type of infection, age, and sex, based on first episode of infection only, Seattle, Wash., July 1, 1972–Dec. 31, 1975

Age group [1] (years)	Type of infection											
	Nasopharynx (N=77)		Skin (N=371)		Skin and nasopharynx (N=43)		Total cases (N=491)		Carriers (N=67)		Total [1] cases and carriers (N=558)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0–4	1	0	..	..	..	..	1	0	2	2	3	2
5–9	1	2	..	..	..	..	1	2	4	2	5	4
10–14	2	1	..	1	..	..	2	2	2	3	4	5
15–19	6	1	1	1	..	..	7	2	4	0	11	2
20–29	11	3	36	13	4	4	51	20	5	4	56	24
30–39	12	6	90	16	10	1	112	23	10	7	122	30
40–49	12	2	88	5	9	0	109	7	7	4	116	11
50–59	9	0	78	0	10	0	97	0	4	0	101	0
60–69	5	1	31	2	4	1	40	4	3	1	43	5
70–79	0	0	2	0	..	..	7	0	1	0	8	0
80 and over	1	1	2	0	..	..	3	1	1	1	4	2
Total	60	17	333	38	37	6	430	61	43	24	473	85

[1] Median age for males was 43 and for females 31.

that required multiple admissions for treatment. Twenty-three persons had been infected 3 times, and 10 had been infected 4 or more times. Ninety percent of the repeat incidents involved diphtheritic skin infections. Only one carrier had repeated carrier status.

There has been a cyclic shift in both biotype and toxigenicity of *C. diphtheriae* isolates. Initially, skin isolates were primarily nontoxigenic mitis biotype, whereas nasopharyngeal isolates were toxigenic gravis and intermedium biotypes. During the first 6 months of 1973 there was a marked decline in toxigenic isolates. A reversal occurred during early 1974 when more than 90 percent of the isolates were toxigenic intermedium *C. diphtheriae*. By mid-1975 only 35 percent of the isolates were toxigenic, intermedium biotype. Isolates from patients with repeat infections showed an identical pattern.

Casefinding. In an attempt to rapidly identify other possible unknown cases and carriers, culture screening was initiated in 15 hotels and 4 taverns frequented by previously diagnosed patients. Cultures were taken from students and teachers who were exposed to diphtheria in 4 schools and from persons in 3 nursing homes and 10 other facilities. Of 1,166 cultures taken, only 17 were positive.

Because of these poor yields, more intensive surveillance was undertaken by medical facilities that serve Skid Road residents. Cultures were taken from any patient with pharyngitis or questionable skin infection and screened for *C. diphtheriae*. A maximum of three skin lesions from each patient was sampled. Positive lesions varied from chronic stasis ulcers to burn or traumatic wounds with secondary infections.

Since laboratory capacity for accurate identification of *C. diphtheriae* was limited, close and constant communication was maintained with private physicians to confine culture screening to the high-risk group and to prevent unnecessary overloading in our laboratory.

Isolation and quarantine. Most patients who were positive on screening were difficult to relocate, and they could not be relied upon to seek preventive, diagnostic, or treatment care on their own initiative. Only a few could be expected to remain in quarantine within their own housing units and to take oral medications as instructed.

To get unreliable diphtheria patients out of public circulation, hospitalization was provided for at least 1 week. Since toxigenicity tests and biotyping were delayed, most patients were quarantined on the basis of a positive culture. In some instances, hospitalization was recommended because of a questionable or positive stained smear. Children were hospitalized at the Children's Orthopedic Hospital.

Many patients were in an acute state of alcoholism when located. The assistance of police officers was occasionally needed to get them placed under hospital quarantine, but time-consuming court procedures were not necessary.

Contact tracing. Patient interviewing for close contacts occurred as soon after quarantine as possible, but often this was not feasible until the alcoholic patient became sober. Even then the sketchy and inadequate information that was provided frequently precluded successful contact tracing. During 1975, after patients' written consent was obtained, they were photographed. These photographs have been helpful in more effective identification of close contacts.

Control of environmental contamination. Since environmental contamination was recognized in the first cluster outbreak, 391 items in 18 dwelling units, occupied by patients with skin or nasopharyngeal infections, were subjected to culture screening for toxigenic *C. diphtheriae*. Half of the units had positive cultures, and 8 percent of the items, which varied from clothing and bedding to upholstered furniture and rugs, were positive. Patients with skin diphtheria were twice as likely to contaminate their immediate environment as those with only nasopharyngeal disease (5 of 7 versus 4 of 11). This survey information was the basis for initiation of a decontamination program for all dwelling units occupied by patients with multiple skin lesions that were positive for *C. diphtheriae*.

From October 1972 until July 1974, a total of 97 dwelling units were decontaminated by the sanitation division of the health department. A phenolic solution (Pascophene 1:128) was used as the cleansing agent. Items which could not be readily sanitized were destroyed by incineration. Because of the heavy drain on health department resources in carrying out these procedures, the program was discontinued in 1974. Data collected for the preceding 23-month period, analyzed by McCormick (*3*), indicated that routine decontamination had no beneficial effect in preventing reinfection.

The following tabulation shows the association between environmental contamination and reinfection for all case types and for skin cases only.

Reinfected and not reinfected	*Decontamination*	*No decontamination*
All case types[1]:		
Reinfected	7	0
Not reinfected	37	40
Skin cases only[2]:		
Reinfected	7	37
Not reinfected	0	40

[1] $X^2 = 1.56$, P .05, $df = 1$. [2] $X^2 = 5.02$, P .05.

Treatment of so many patients with skin diphtheria in various medical facilities caused concern over possible transmission of disease to patients admitted for care of other conditions. Since 20–40 percent of the environmental cultures that were taken from all five facilities serving the patients were positive for *C. diphtheriae,* the possibility of spread via fomites was a distinct risk. The positive cultures most frequently came from areas and instruments that had direct patient contact during examination or treatment. These culture results were used to redirect sanitizing efforts toward objects and areas that need the most attention. Two patients did acquire nosocomial diphtheria, but it was impossible to determine whether spread was by fomites or health personnel.

Protective immunizations. When casefinding began, an aggressive program of immunization was also started. Adult Td was offered to all persons who submitted to screening cultures in hotels and taverns. Special clinics at strategic Skid Road sites were initiated with assistance from local U.S. Army reserve personnel. During December 1972 and January 1973, more than 2,000 residents received at least 1 dose of toxoid. Medical facilities providing general care to residents were encouraged to promote Td immunizations, and they were given the vaccine to do so. Private physicians and hospital medical staffs were encouraged to use Td instead of tetanus toxoid for wound prophylaxis. From 1972 to 1975 approximately 28,000 doses of Td were administered to adults working or living in Skid Road.

During the 3½-year period, July 1, 1972–December 31, 1975, emphasis was directed toward updating diphtheria-tetanus immunizations among school children of all grade levels. More than 85,000 children were given the necessary doses of vaccine, mainly Td boosters. School surveys indicated that at least 85 percent of the elementary school children were fully protected against diphtheria and less than 5 percent had not had diphtheria immunizations. All major hospitals in the downtown area had provided necessary immunizations to medical and nursing staffs.

Discussion

Although skin diphtheria in the United States appears to be unique to Seattle and the State of Washington, it is not unknown in this part of North America. Cockcroft and associates (*4*) recently reported on a smaller outbreak in Vancouver, B.C., Canada, among Skid Road residents. Dr. E. J. Bowmer, director of laboratories, in a personal communication, February 1975, indicated a continuing problem in Vancouver since 1973. During 1974, toxigenic intermedius *C. diphtheriae* isolates were recovered from 370 patients in British Columbia. Twenty-eight percent of these isolates were from patients with skin lesions. Two-thirds of the positive patients were residents of metropolitan Vancouver. Jellard (*5*), in 1972, reported 248 diphtheritic skin infections among residents of northern Alberta and the Northwest Territories.

Bolyai (*6*) analyzed limited outbreaks of diphtheria within the State of Washington since 1955. The majority of outbreaks occurred on or within 15 miles of Federal Indian Reservations. In 1973, Kremers described an outbreak of diphtheria in Goldendale, Wash. (*7*). The first 4 cases were cutaneous infections among Indian children; a total of 27 cases and 54 carriers, mostly children, were identified. This outbreak could not be linked to the ongoing Seattle epidemic. Although a definite epidemiologic trail could not be established for importation of diphtheria to Seattle, evidence favors such an occurrence. Approximately 40 percent of the patients or contacts interviewed admitted traveling outside Seattle during the previous 3 months—several had traveled to Canada. It is probable that Seattle and Vancouver have shared a common disease problem since 1972.

The high ratio of skin infections over nasopharyngeal disease, in part, represents our aggressive search for skin diphtheria. It may also reflect the co-existence of both types of infection during an outbreak, as described by Liebow and Bumstead (*8*). In 1972, Bray and co-workers (*9*) described similarly related infections among children in Trinidad. Both hypothesized a pre-existing reservoir of skin diphtheria before nasopharyngeal disease outbreaks. This is the likely sequence of events in Seattle.

In 1970, Belsey (*10*) pointed out the significance of environmental contamination and how it may persist for variable lengths of time. The suspicion that fomites may be important in transmission and possible reinfection cannot be disregarded. Medical facilities that care for diphtheria patients have a

special responsibility to insure that adequate sanitizing procedures are undertaken to minimize the possibility of nosocomial transmission.

The value of decontaminating individual dwelling units is contingent upon whether the occupant maintains good personal and environmental hygiene after the unit is sanitized and whether the treated patient remains in the unit on a more permanent basis. Neither of these conditions can be realistically achieved for much of the Skid Road population, which perhaps was why we were unable to demonstrate the value of continuing an expensive and time-consuming sanitizing program.

Our data do not identify the major cause of recidivism. In some instances hospital treatment may not have completely cleared the patient of diphtheria organisms even though post-treatment cultures were negative. Other patients may have become reinfected through environmental contamination or re-exposure to other infected persons.

The intensive immunization program directed toward Skid Road residents was undertaken to minimize morbidity and mortality among susceptibles. Of the 36 infected persons under age 20, 80 percent had previously received adequate (3 doses) vaccine protection, whereas only 20 percent of the infected adults were known to be similarly protected. There was no evidence that the four adults who died had received any diphtheria immunizations during their lifetimes.

Craig, in 1962, described the possible self-immunization of adults from inapparent diphtheria infections (*11*). It is possible that patients with skin infections experience a similar phenomenon. This could explain the lack of serious morbidity among patients with only skin involvement.

Other than to minimize spread of diphtheria to the non-Skid Road population, it is doubtful that any of our control measures have altered the natural course of diphtheritic skin diseases in the area. The shift in biotype and toxigenicity is the most hopeful sign that the disease will eventually submerge to its previous uncertain reservoir. Until this shift is complete, we see no alternative but to continue present control measures.

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SYNOPSIS

PEDERSEN, A. H. B. (Seattle-King County Department of Health), SPEARMAN, JEAN, TRONCA, EVELYN, BADER, MAX, and HARNISCH, JAMES: ***Diphtheria on Skid Road, Seattle, Wash., 1972-75. Public Health Reports, Vol. 92, July–August 1977, 336–342.***

From July 1972 to December 1975, an unusual outbreak of diphtheria in Seattle, Wash., resulted in a total of 558 cases and carriers, mostly among heavy alcohol users. Skin infections were predominant. Four white men died. The highest attack rate was among native American Indians. Environmental contamination and poor personal hygiene were believed to be important in continuation of the epidemic, but could not be proved. Control measures included casefinding, isolation and quarantine, sanitizing dwelling units, and mass immunization with Td toxoid.

The high-risk geographic area was the city's Skid Road. This area continues to be the reservoir of continuing infection, but not all population subgroups there have been at equal risk. Spread to other geographic areas of the city and county has been minimal and remains under control.